Journal of Applied Botany and Food Quality 87, 93 - 96 (2014), DOI:10.5073/JABFQ.2014.087.014

[1]Department of Horticulture, Faculty of Agriculture, University of Süleyman Demirel, Isparta, Turkey
[2]Fruit Research Station, Eğirdir, Isparta, Turkey
[3]Department of Soil, Faculty of Agriculture, University of Süleyman Demirel, Isparta, Turkey

# Nutritional constituents of wild-grown black mulberry (*Morus nigra* L.)

**F. Koyuncu[1], M. Çetinbaş[2*], E. Ibrahim[3]**

(Received February 4, 2014)

## Summary

Some chemical properties were determined in completely ripe fruits and fully developed leaves of black mulberry (*Morus nigra* L.) genotypes, grown in Mahmatlar, Turkey. Crude protein was found as the most abundant component in both fruits (10.25 %) and leaves (25.72 %). Native black mulberry fruits had higher content of total sugar (6.25 %), crude fat (5.75 %) and crude protein than those of the other berries. Analyses of mineral composition (K, Na, P, Ca, Mg, Zn, Fe, Mn and Cu) results indicated that K was the main mineral of fruit followed by Na and P. Furthermore, black mulberry leaves were rich in sodium, calcium and potassium. Black mulberry should be more widely used because of its potential nutrient contribution for human and also for feeding animals.

### Abbreviations

K: Potassium, Na: Sodium, P: Phosphorus, Mg: Magnesium, Ca: Calcium, Fe: Iron, Mn: Manganese, Zn: Zinc, Cu: Copper

## Introduction

*Morus nigra* is a member of *Morus* genus in the *Moraceae* family. Black mulberry grows wildly in various parts of the world especially in the temperate regions or Mediterranean climates (Verheij and Coronel, 1991; Tutin, 1996). In Turkey, black mulberry is cultivated for fruit production and its dark shade in the summer. The perennial woody plant has a height of about 10 m (Yaltirik, 1982). It flowers from April to May, and fruit ripens from July to September (Koyuncu et al., 2004; Koyuncu, 2004). Black mulberry is considerably valued for its delicious fruits which are 2-3 cm long; they have a weight of approximately 5-6 g and black-purple color (Koyuncu et al., 2004). The fruits fall from the tree when they are fully ripe. Therefore, fruit harvesting is similarly difficult since fruit detachment is not easy to achieve unless they are fully ripe (Gerasopoulos and Stavroulakis, 1997). Nevertheless, by the use of fruit collection nets in combination with tree shaking, followed by hand sorting (Holland et al., 1992) or by growing short grass under the tree, harvesting is managed relatively easily. Fruits are consumed fresh, dried, cooked or are used in preserves and tea. Fruits of black mulberry have aromatic, laxative and anti-pyretic actions (Chopra et al., 1988). The syrup is obtained from black mulberry fruits is believed to have medicinal purpose (Baytop, 1984). In addition it is used in jam, marmalade, paste, pulp, jelly and juices. Also, it has an exceptional coloring effect, especially for ice-cream. Furthermore, fruits and leaves are used for pharmacogical actions all over the world. In our country, from its fruits we have some products such as pekmez. Pekmez is defined as the prufication of the fresh and dried black mulberry from the external matters, and defined as a product whose unfermented juice's concentration at the sun or in a vacuum till certain extend (Anonim, 1996). Since black mulberry fruits decompose very quickly, by making pekmez it is possible to have long lasting usage of the black mulberry (Erdoğan and Çakmakçı, 2005).

The researches have shown that the leaves are antibacterial, astringent, diaphoretic, hypoglycemic, odontalgic and ophthalmic (Duke and Ayensu, 1985). The leaves are collected in the late autumn and can be used fresh but generally they were dried. They should be used internally in the treatment of colds, influenza, eye infections and nosebleeds (Bown, 1995).

As interest in fruit plants, especially berries, is now growing, it is important to investigate the composition of the berries commonly grown in each country. Mineral compounds are essential protective nutrients for the maintenance of nutritional and healthy body. The human body cannot synthesize minerals therefore they must be obtained through the diet. Adequate amounts of minerals should be included in the daily diet to supply of minerals for body. While it is clear that fruits have superior source of minerals in human nutrition. It is possible that many fruit varieties may have a better effect on human metabolism because of their different nutritional composition. Therefore, some native fruits such as black mulberry are still important due to their nutrients, texture and medicinal properties.

Except for the limited study of Koyuncu et al. (2004), Koyuncu (2004a), Koyuncu (2004b) on black mulberry, there is no detailed information on the nutritional composition of fruits and leaves of black mulberry. That information is essential to inquire about nutritive constituents of black mulberry. The research aimed to determine the nutritional value of 8 selected black mulberry genotypes.

## Materials and methods

### Sampling

The fruits and leaves analyzed in this experiment were collected from native black mulberry genotypes, which were evaluated as promising by Koyuncu et al. (2004) in Mahmatlar, Turkey. The fruits were harvested in July and transported to the laboratory in iceboxes immediately. The fruit samples were stored in a freezer at -80 °C until usage. The fully developed young leaf samples were collected from current year's shoots in July representing whole tree from four sides to determine mineral composition of trees.

### Proximate analysis

Basic proximate composition analyses were conducted on black mulberry fruits. For this purpose, fifty grams of each fruit sample were used after dried at 65 °C to constant weight. These samples were ground with a stainless-steel mill for analytic procedures. In accordance with AOAC methods (1995), moisture was determined by weight loss after heating in an oven at 105 °C, ash in a muffle furnace at 550 °C for 5 h. To determine total sugars, a modified Anthrone method (Sanz et al., 1987) was used. Crude fat as estimated by exhaustive extraction with petroleum ether using Soxhlet apparatus according to the AOAC (1984). Crude protein was calculated from nitrogen, determined by Kjeldahl method, multiplying the value by 6.25 as recommended by Bremler (1965).

* Corresponding author

**Mineral elements analysis**

The mineral contents were analyzed on both leaf and fruit samples. Samples were washed thoroughly with fountain water, dilute acid (0.2 N_HCl) and distilled water to remove surface residues, and dried at 70±5 ºC. Dried samples were ground with a stainless-steel mill for analytic procedures.

Nitrogen concentration in samples was determined according to Kjeldahl method (Bremler, 1965) in which 1g sample digested in concentrated $H_2SO_4$ and distilled with NaOH (40 %). The ammonium N was fixed in $H_3BO_3$ (2 %) and titrated with 0.1N $H_2SO_4$. To determine K, Na, P, Ca, Mg, Zn, Fe, Mn and Cu concentration of plant (leaf and fruit), dried samples were grinded then 1 g of samples were wet-digested in $HNO_3$+$HClO_4$ acid mixture. Digested material was dissolved and filled up to 100 ml with distilled water. Phosphorus concentration was determined with molibdo-vanado phosphoric acid method using a Shimadzu UV-1208 spectrophotometer at 430 nm. Na, K and Ca contents were evaluated using a flame photometer (Jenway PFP 7). The other nutrients (Mg, Zn, Fe, Mn, Cu) concentrations were measured using an atomic absorption spectrophotometer (Varian AA240FS) (Kaçar, 1972).

**Statistical analysis**

All analyses were carried out in triplicate and the mean calculated. The data were analyzed using Analysis of Variance (ANOVA). Duncan's Multiple Range test was used to compare mean values. Significance was accepted at P<0.01 level. Variety was the only independent variable.

## Results and discussion

Data of biochemical analysis of fruits and leaves of 8 mulberry genotypes are summarized in Tab. 1, 2, and 3. Quantitative results indicate the difference among mineral contents of different genotypes. All samples present a similar profile composed of minerals.

**Proximate composition of black mulberry fruit and leaf**

The moisture content of fresh fruits in the eight genotypes (M-5, M-8, M-11, M-14, M-17, M-18, M-22, M-28) were found to be between 77.30 % (M-17) - 84.27 % (M-28). The average moisture content of black mulberries (*Morus nigra* L.) is 81.6 % in Antalya southern of Turkey region which was found by Ozdemir and Topuz (1998). Ercişli and Orhan (2007) also found that the moisture content of fresh fruits 72.6 %. These differences can be attributed to ecological factors and also harvesting time. The average crude fat compounds were 5.75 %, and total ash compounds were determined between 0.36 % - 0.12 % (Tab. 1).

Crude fat compounds of genotypes were significantly different whereas ash compounds were not. The crude fat contents were lower than those reported by Ercişli and Orhan (2007). The fruits average total sugar was 6.25 %. In black mulberries sucrose concentration is low and total sugar mainly consists of reducing sugars (Özdemir, 1998). In that sense, the sugars in black mulberry fruits are important for human. Significant differences were found sugar concentration of fruits with the genotype M-11 showing the highest concentration (7.26 %) (Tab. 1). Our results coincide with the other studies (Holland et al., 1992; Anonymous, 2001) showing sugar concentrations in black mulberry fruits is between 6-9 %. The protein concentrations in black mulberry fruits ranged between 7.66 % - 12.93 % according to other authors (Bamikole et al., 2005; Glosh et al., 2003; Erdoğan and Çakmakçı, 2005; Kitahara et al., 2002; Martin et al., 2002; Machii et al., 2002; Srivastava et al., 2006). In leaves, M-17 genotype (29.15 %) had the highest crude protein, M-14 had the lowest with 20.94 % (Tab. 1). Significant differences on crude protein concentration was found among genotypes in fruits and leaves (Tab. 1).

**Mineral composition of black mulberry fruit and leaf**

Mineral concentrations of fruit and leaf from black mulberries were given at Tab. 2 and 3. As seen in Tab. 2, the main mineral of black mulberry is K, followed by Na, P and Mg. Mineral concentrations of fruits showed differences among genotypes (except for Mg and Fe). The mean values of K, Na, P, Mg, Ca, Fe, Mn, Zn and Cu were 1041 mg/100g, 277 mg/100g, 170 mg/100g, 128 mg/100g, 32 mg/100g, 7.07 mg/100g, 5.63 mg/100g, 3.02 mg/100g, 0.34 mg/100g, respectively. These findings agree with previous studies (Cemeroğlu and Acar, 1986; Ercişli and Orhan, 2007; Erdoğan and Çakmakçı, 2005; Holland et al., 1992).

In a research conducted by Ozdemir and Topuz (1998), black mulberry fruits in Antalya had higher mineral contents than our results, but it was stated that the main minerals of black mulberry fruits were K, Ca, P and Mg. Ercisli and Orhan (2007) found higher P, K, Ca and Mn contents. Looking at the contents of Cu we saw similarity with the study but they also found lower Zn. These differences may be due to ecological factors, growing conditions and genetic factors. Mineral nutrition of plant is controlled by

**Tab. 1:** Proximate composition of black mulberry fruits and leaves (%).

| | Fruit | | | | | Leaf crude protein |
|---|---|---|---|---|---|---|
| **Genotype** | **Moisture** | **Total sugar** | **Crude fat** | **Ash** | **Crude protein** | |
| **M-5** | 81.97 a | 7.05 a | 5.65 b | 0.17 | 10.04 c | 29.07 a |
| **M-8** | 81.49 a | 7.08 a | 5.92 ab | 0.24 | 9.76 c | 25.34 b |
| **M-11** | 82.86 a | 7.26 a | 5.52 b | 0.21 | 9.56 c | 24.06 b |
| **M-14** | 82.35 a | 6.44 b | 6.71 a | 0.36 | 10.36 bc | 20.94 c |
| **M-17** | 77.30 b | 5.45 d | 6.79 a | 0.23 | 10.31 bc | 29.15 a |
| **M-18** | 84.20 a | 5.09 d | 6.06 ab | 0.28 | 11.39 b | 25.00 b |
| **M-22** | 84.03 a | 6.11 bc | 6.22 ab | 0.13 | 12.93 a | 28.59 a |
| **M-28** | 84.27 a | 5.53 cd | 3.15 c | 0.12 | 7.66 d | 23.61 b |
| **Mean** | 82.31 | 6.25 | 5.75 | 0.21 | 10.25 | 25.72 |
| **Max** | 84.27 | 7.26 | 6.79 | 0.36 | 12.93 | 29.15 |
| **Min** | 77.30 | 5.09 | 3.15 | 0.12 | 7.66 | 20.94 |

*) Different letters in the same column indicate significant differences, according to Duncan's multiple range test (P<0.01).

**Tab. 2:** Mineral composition of black mulberry fruits (mg/100 g).

| Genotype | K | Na | P | Mg | Ca | Fe | Mn | Zn | Cu |
|---|---|---|---|---|---|---|---|---|---|
| **M-5** | 999 b* | 205 e | 150 c | 148 | 33 bc | 6.77 | 4.20 b | 3.17 ab | 0.58 a |
| **M-8** | 1254 a | 247 cd | 168 bc | 105 | 42 ab | 5.50 | 3.83 b | 2.21 b | 0.28 b |
| **M-11** | 818 c | 309 ab | 154 c | 136 | 31 bcd | 4.47 | 3.93 b | 3.09 ab | 0.34 b |
| **M-14** | 999 b | 291 ab | 157 bc | 140 | 30 cd | 6.62 | 4.93 b | 3.39 ab | 0.31 b |
| **M-17** | 1165 a | 329 a | 182 b | 152 | 29 cd | 6.65 | 4.40 b | 2.07 b | 0.22 b |
| **M-18** | 1228 a | 279 bc | 160 c | 150 | 27 cd | 5.61 | 5.93 b | 2.77 b | 0.36 b |
| **M-22** | 1264 a | 229 de | 164 bc | 92 | 21 d | 10.34 | 5.17 b | 3.09 ab | 0.36 b |
| **M-28** | 599 d | 329 a | 228 a | 99 | 45 a | 10.59 | 12.67 a | 4.36 a | 0.31 b |
| **Mean** | 1041 | 277 | 170 | 128 | 32 | 7.07 | 5.63 | 3.02 | 0.34 |
| **Max** | 1264 | 329 | 228 | 152 | 45 | 10.59 | 12.67 | 4.36 | 0.58 |
| **Min** | 599 | 205 | 150 | 92 | 21 | 4.47 | 3.83 | 2.07 | 0.22 |

*) Different letters in the same column indicate significant differences, according to Duncan's multiple range test (P<0.01).

**Tab. 3:** Mineral composition of black mulberry leaves (mg/100 g).

| Genotype | Na | Ca | K | Mg | P | Mn | Fe | Zn | Cu |
|---|---|---|---|---|---|---|---|---|---|
| **M-5** | 649 h* | 1226 c | 812 d | 327 b | 117 d | 22.20 bc | 12.50 b | 4.84 | 0.48 abc |
| **M-8** | 1008 g | 1759 a | 1217 ab | 431 ab | 127 d | 21.93 bc | 16.60 ab | 6.62 | 0.51 abc |
| **M-11** | 1368 f | 1847 a | 1103 bc | 431 ab | 153 bc | 25.10 ab | 13.97 b | 6.31 | 0.44 bc |
| **M-14** | 1727 e | 1788 a | 978 c | 387 ab | 171 ab | 27.23 ab | 13.58 b | 6.45 | 0.41 c |
| **M-17** | 2086 d | 1660 a | 1223 ab | 372 b | 162 ab | 27.30 ab | 20.70 a | 5.27 | 0.53 ab |
| **M-18** | 2205 c | 1542 ab | 994 c | 359 b | 150 bc | 26.20 ab | 11.79 b | 5.99 | 0.44 bc |
| **M-22** | 2684 b | 1552 ab | 1306 a | 387 ab | 180 a | 30.00 a | 15.38 b | 7.49 | 0.56 a |
| **M-28** | 3402 a | 1325 bc | 818 d | 521 a | 137 cd | 18.85 c | 14.80 b | 5.99 | 0.53 ab |
| **Mean** | 1891 | 1587 | 1056 | 402 | 149 | 24.85 | 14.91 | 6.12 | 4.90 |
| **Max** | 3402 | 1847 | 1306 | 521 | 180 | 30.00 | 20.70 | 7.49 | 5.60 |
| **Min** | 649 | 1226 | 812 | 327 | 117 | 18.85 | 11.79 | 4.84 | 4.13 |

*) Different letters in the same column indicate significant differences, according to Duncan's multiple range test (P<0.01).

environment, soil and plant factors (MARSCHNER, 1995). Since the uptake of nutrients from the soil is genetically controlled, plant species and varieties show different response to nutrients even when they are grown in the same conditions (TSIPOUTIDIS et al., 1990; ERSHADI and TALAIE, 2001; ERDAL and BAYDAR, 2005; KUÇUKYUMUK, 2007).

As shown in Tab. 3, Na, Ca, K, Mg and P values of black mulberry leaves varied from 649 mg/100g (M-5) to 3402 mg/100g (M-28). Differences among the black mulberry genotypes were observed based on the mineral concentrations. It can be stated that most of the minerals constituting the leaves of black mulberry trees from Isparta district were just constituted by Na, Ca, K and Mg. In the study conducted by KITAHARA et al. (2002), it was pointed out that the mineral patters of leaf samples mostly consist of Ca, K, and Mg. The mineral composition of leaves depended not only on the types, but also on the growing conditions, such as soil and geographical conditions. In this study, Na was predominant, followed by Ca, K, Mg, P, Mn, Fe, Zn and Cu.

Black mulberry fruits which are cultivated in Isparta than other regions have rich nutrition elements. For this reason they are important raw material for food technology production (jam, marmalade, paste, pulp, jelly, juice, pekmez, etc.). Their leaves have also rich nutrition elements like their fruits. Leaves can be used for animal nutrition, tea production and they can be used for various purposes. Karadut leaves which are cultivated in Isparta region are very important for the reasons above. However, in order to produce certain crops from black mulberry industrially, relevant researches on this purpose should be conducted and orchards with appropriate varieties should be set up.

## References


ANONIM, 1996: Dut pekmezi. Turk standardı TS12001, Ankara, Turkey.

ANONYMOUS, 2001: Mulbery, http://crtg.org/pubs/tt/mulberry.html.

AOAC, 1984: Official Methods of Analysis, 14th edn. Washington, DC: Association of official analytical chemists.

AOAC, 1995: Official Methods of analysis, 16th edn. Washington, DC: Association of official analytical chemists.

BAMIKOLE, M.A., IKHATUA, M.I., IKHATUA, U.J., EZENWA, I.V., 2005: Nutritive value of mulberry (*Morus* spp.) leaves in the growing rabbits in Nigeria. Pak. J. Nutr. 4, 231-236.

BAYTOP, T., 1984: Türkiye' de bitkilerle tedavi. İstanbul universitesi yayınları, Istanbul, Turkey.

BOWN, D., 1995: Encyclopadia of herbs and their uses, Dorling kindersley, Londan, UK.

BREMLER, J.M., 1965: Total nitrogen (Methods of soil analysis). Am. Soc. Agron. Inc. Medison, USA.

CEMEROGLU, B., ACAR, J., 1986: Meyve sebze isleme teknolojisi, Sanem Matbaacılık, Ankara, Turkey.

CHOPRA, R.N., CHOPRA, I.C., HONDA, K.L., KAPUR, L.D., 1988: Chopra's

indigenous drugs of India 2nd. Dhar & Sons Pvt. Ltd.

DUKE, J.A., AYENSU, E.S., 1985: Medicinal plants of china. Reference publications inc., ISBN 0-917256-20-4.

ERCIŞLI, S., ORHAN, E., 2007: Chemical compositin of white (*Morus alba*), red (*Morus rubra*) and black (*Morus nigra*) mulberry fruits. Food Chem. 103, 1380-1384.

ERDAL, I., BAYDAR, H., 2005: Deviations of some nutrient concentrations in different parts of safflower cultivars during growth stages. Pak. J. Bot. 37, 601-611.

ERDOGAN, U., ÇAKMAKÇI, R., 2005: Ulkemizde dut (*Morus spp*.) uretimi. III. Ulusal Meslek Yuksek Okulları Sempozyumu, 28-30 Eylul, Turkey.

ERSHADI, A., TALAIE, A., 2001: The effect of clonal rootstocks on leaf mineral composition of several apple cultivars. ISHS, 317-320.

GERASOPOULOS, D., STAVROULAKIS, G., 1997: Quality characteristics of four mulberry (*Morus* sp.) cultivars in the area of Chania, Greece. J. Sci. Food Agric. 73, 261-264.

GHOSH, L., ALAM, M.S., ALI, M.S., SHOHAEL, A.M., ALAM, F., ISLAM, R., 2003: Changes in some biochemical parameters of mulberry (*Morus* sp.) leaves after infected with leaf spot disease. Online J. Biol. Sci. 3, 508-514.

HOLLAND, B., UNWIN, I.D., 1992: Fruits and nuts. The Bath Press, UK.

KAÇAR, B., 1972: Bitki Besleme Uygulama Kılavuzu. Ankara Üni. Zir. Fak. Yayınları, Ankara, Turkey.

KITAHARA, N., SHIBATA, S., NISHIDA, T., 2002: Management and utilisation of mulberry for forage in Japan, 1. Productivity of mulberry-pasture association system and nutritive value of mulberry, FAO Electronic conference on mulberry for animal production (*Morus 1-L*) 147.

KOYUNCU, F., KOYUNCU, M.A., YILDIRIM, F., VURAL, E., 2004: Evaluation of black mulberry (*Morus nigra* L.) genotypes from lakes region, Turkey, Europ. J. Hort. Sci. 69, 125-131.

KOYUNCU, F., 2004: Morphological and agronomical characterization of native black mulberry (*Morus nigra* L.) in Sütçüler, Turkey. Plant Genetic Resources Newsletter 138, 32-35.

KOYUNCU, F., 2004: Organic acid composition of native black mulberry fruit. Chem. Nat. Compd. 40, 367-369.

KUÇUKYUMUK, Z., 2007: Investigation of rootstock and variety effect on mineral nutrition of apple trees. University of Süleyman Demirel, Natural and Applied Science, Isparta, Turkey, Master Thesis.

MACHII, H., KOYAMA, A., YAMANOUCHI, H., 2002: Mulberry breeding, cultivation and utilization in Japan. FAO Electronic conference on mulberry for animal production (*Morus1-L*) 147.

MARSCHNER, H., 1995: Mineral nutrition of higher plants. Academic press, San Diego, USA.

MARTIN, G., GARCIA, F., REYES, F., HERNANDEZ, I., GONZALEZ, T., MILERA, M., 2002: Agronomic studies with mulberry in Cuba. FAO Electronic conference on mulberry for animal production (*Morus1-L*) 147.

OZDEMIR, F., TOPUZ, A., 1998: Antalya yöresinde yetiştirilen farkli dutlarin bazi kimyasal özellikleri. Derim 15, 30-35.

SANZ, A., MARTINEZ-CORTINA, C., GUARDIOLA, J.L., 1987: Changes in carbonhydrates and mineral elements in *Citrus* leaves during flowering and fruit set. Physiol. Plant. 69, 93-98.

SRIVASTAVA, S., KAPOOR, R., THATHOLA, A., SRIVASTAVA, R.P., 2006: Nutritional quality of leaves of some genotypes of mulberry (*Morus alba*). Int. J. Food Sci. Nutr. 57, 305-313.

TSIPOUTIDIS, C., SIMONIS, A.D., BLADENOPOULOU, S., ISAAKIDIS, A., STYLIANIDIS, D., 1990: Nutrient element variability in the leaves of peach trees in relation to cultivar and rootstocks. 23rd International Horticulture Congress, Firenze, August 27-September 1, Italy.

TUTIN, G.T., 1996: Morus L. In: Tutin, G.T., Burges, N.A., Chater, A.O., Edmondson, J.R., Heywood, V.H., Moore, D.M., Valentine, D.H., Walters, S.M., Webb, D.A. (eds.), In Flora Europe Psilotaceae to Platanaceae Second Edition, 100-106. Cambridge University Press, Australia.

VERHEIJ, E.W.M., CORONEL, R.E., 1991: Fruits and nuts. Plant Resources of South-East Asia 2. Edible, Netherlands.

YALTIRIK, F., 1982: Morus. In: Davis, P.H. (ed.), Flora of Turkey, 641-642. Edinburgh University Press, Edinburgh.

Address of the corresponding author:
M. Çetinbaş, Fruit Research Station, Eğirdir, 32500, Isparta, Turkey.
E-mail: melikecetinbas@gmail.com